

In another work on "Natural Philosophy," we read that, "The tides proceed from the attractive force of the sun and moon, which diminish the gravity of the waters of the ocean, or, which is the same thing, draw or lift up the water toward themselves. The force of attraction acts in straight lines; and, therefore if we draw two straight lines from the moon's



centre, M C, M F, to represent this force, acting on the parts C and F, it is obvious that the water at C and at F will not be raised, but depressed, by being drawn away from C to D and from F to H; and so of every part of the circle C E F. But the water will at the same time rise on the side of the earth away from the moon, because the earth's centre being more strongly drawn towards the moon than the point N, recedes from N, which is the same in effect as if the water at N receded or rose up from the earth's centre."

By the earth's rotation on its axis, the two tide waves will be continually making their round over the ocean.

The force of attraction acting in straight lines, it should be high water at any place in the open sea when the moon is upon the meridian of that place; but, in fact, the greatest (and least) heights of the water at such a place do not occur till about three hours after the periods fixed in this supposition. The delay is thus explained: the elevated parts of the sea have received such an impulse towards ascent, that they continue to rise after the earth's rotation has carried them from under the line of the direct attraction of the moon; this impulse being also aided for a time by the moon continuing to attract the water upwards, though in a less degree.

The sun, though his attractive influence is three times less than that of the moon, acts upon the ocean in the same manner, though in a less degree. When these two bodies unite their influence, which they do at the seasons of new and full moon, the tides naturally rise the highest: they assist each other in raising the ocean as before described, and depressing it in a corresponding manner.

Of the irregularities in the tides, caused by the continually changing position of the sun and moon, those are the greatest which are occasioned by the obstacles offered by the land to the ebb and flow of the waters. The impediments created by shallows in the ocean, and by the shores, bays, gulfs, and promontories of islands and continents are such, that the tides are greatly delayed, altered both in degree and direction, and in many places so accumulated, that they rise to heights far exceeding what is witnessed in the open ocean." If, as Humboldt says, the tide waves of the waters of the ocean, in the open sea, rise hardly to a few feet, they mount, in consequence of the configuration of the coasts, which oppose the coming tide, to 50 feet at St. Malo, and to 65 to 70 feet in Acadia.*

This is, as far as I have been able briefly to represent it, the present theory of the tides. Let us now consider

THE ANOMALIES OF THE PRESENT THEORY OF THE TIDES.

And here I cannot do better than have recourse to a work under the preceding title by Thomas Kerigan, R.N. F.R.S. In his address to the reader he says:—

"I have shown that when the moon is vertical to St. Helena she is 2,362 miles nearer to it than to the point called "the Land's End," in Cornwall; and that as her reputed power of gravitation is not of sufficient force to raise a tide at the former place, it cannot be the cause of the high tide which flows at "the Land's End," particularly since she is on the meridian of both places at the same instant,—which adds another link to the chain of proofs already given respecting the negative influence of the moon over the tides of the ocean."

* Acadia, the French and genuine Indian name for Nova Scotia; it is there, in the "Bay of Fundy," that the tide rises about 70 feet.

Besides this palpable instance of the moon's exercising no attractive influence whatever upon the ocean, I copy from his pamphlet, page 8:—

"The Theory of the Tides expressly states, that 'the action of the moon over the waters of the ocean is the most direct and intense when she is moving in the equinoctial; and, should the times of conjunction or opposition take place when she is so circumstanced, and at her least distance from the earth, the tides will be the greatest possible. But, in all cases the highest tides must take place within the tropics; and the nearer any port or harbour is to the equator, the greater will be the force of the tide in such harbour.'"

"Now we know from actual experience that there are no tides at any of the islands within the torrid zone that are 200 or 300 miles from the nearest mainland. At St. Thomas's Island, lying very nearly under the equator, 'in the middle of the ocean, and free from interference on every side,' we find from actual observation that instead of a high tide in that harbour, there is a total absence of any thing like a rise and fall of the water, except the few inches flux and reflux which keep pace with the alternate returns of the sea and the land breezes, the same as at most other islands adjacent to the equator, and that are at a proper distance from the main land, as already noticed."

These facts, and many other valuable remarks of the author, must for ever nullify the theory of the attraction of the waters of the ocean by the moon. But, besides these anomalies, there are others which I will notice.

According to Sir I. Newton, it is the attraction of the earth which keeps the moon, revolving by centrifugal force, in her orbit; and Thomas Kerigan, in his treatise, states, that by calculation based upon the laws of universal gravitation, the moon is not retained in her orbit by the mere force of terrestrial attraction; for, if left entirely to that, she would fly off from her present orbit and be lost upon the body of the sun.

If, then, the earth attracts the moon, the larger body the smaller one, how can the moon displace the earth, as stated above? And if the earth have more attractive power than the moon; if it attract the distant moon herself—should not then the earth also exercise more attractive power over the water by which it is covered, than the distant moon is said to do? Or is there more affinity between the surface of the waters of the earth and the moon, than between the water and the earth itself? And as the earth, as it were, is drawing down the moon, keeping her forcibly in her orbit, is the moon, in opposition, drawing away in the meanwhile, and lifting up towards herself the waters of the ocean? This would be contradiction, unless it were asserted that the earth and moon attract each other, like positive and negative electricity (see THE BUILDER, No. 450), and that the earth sends forth her waters to attract the moon. But then the waters would come too late; for, as was said above, they do not attain their height until three hours after the moon has passed. Or, if the moon attracts the water, do her attractive rays draw more when exercised in a vertical line, or when in an oblique direction? If more in the former than in the latter, why is the tide highest three hours after the moon has left her vertical position? Is the delay reasonably explained above? If a given power is not able to lift up a certain weight in a vertical line, will it be able to do so in an oblique one? Quite impossible. And this is the same with the moon; her attractive power, if any, would be strongest in the vertical direction; and like the drawing up of a body by machinery or the hand of man, the moment the exercise of vertical power is changed into oblique, without even relaxing the power itself, the body will no longer rise, however fast it may have been drawn, unless a particular impulse upward had been given to it by some extra power suddenly applied. It strikes me much the same as in the case of waterpots (see THE BUILDER, No. 450): the lower cone would not continue to rise, if the upper one were removed from its corresponding vertical position.

Moreover, attractive power is not of a sudden, impulse-imparting nature, nor a thing that accumulates, like the power of a steam-engine, which will be followed by the train, though it should be separated, or have passed away, from it. The rays of attraction (supposing the moon to possess them), like the rays of the sun, are strongest in the vertical line: the former, however, do not accumulate, but are like ropes, by which the moon, in a manner, lifts (as it is said) the water; on the other hand, the rays of the sun do accumulate by refraction and reflection, though they are never so strong as at midday; and this accumulation of heat renders the air warmer in the afternoon than at noon. Thus, the delay of the tide-wave, following the moon three hours after she has passed from her vertical position, cannot be compared with the delay in the warmer state of the air in the afternoon: it is like a room, which will remain warm for some time after the fire of the day has gone out. But, to compare to this the rising of the tide after the moon has passed, would be expecting the water to rise after you have ceased to pump.

Besides this, it must be borne in mind, how enormous ought to be the attraction of the moon, to cause the rise of the water still after she has ceased to attract it in a vertical direction, so much so, as to overcome the opposing pressure of the atmosphere of 15 lb. weight to the square inch.

The earth is said to attract the moon, and yet, according to the theory of the tides, the moon would draw up the entire sea, if the air was not between.

According to the statement quoted, "the water will rise on the side of the earth away from the moon, because the earth's centre is more strongly drawn towards the moon than the point N, and recedes from N, which is the same in effect as if the water at N receded or rose up from the earth's centre."

Now if this were the case that the side of the earth away from the moon leaves the water behind, would it not be more natural still, that, in being so strongly attracted by the moon, the water facing the moon should give way on all sides to the pressure of the atmosphere, and allow the earth to peep out like a man putting his head out from under the water, rather than cause a mountain of water to be raised over it? Or, if the moon exercises more power over the water than over the earth, then the former propositions cannot be true.

It is the same with the attraction of the sun: if he causes the water to rise, then the attraction must not only be more powerful upon the water than upon the earth, but so strong as to raise the water in opposition to the whole atmosphere pressing upon it; or the sun must attract the air and water at the same time in a peculiar manner. If the sun attracts the earth itself in a kind of violent way, then the fluid water, and the still more fluid and elastic air, would give way to the forward impulse of the earth, and cause, as with the moon on the same supposition) low instead of high water. If the sun and moon attract our globe, including its water and atmosphere, in an equal manner as one whole, there would then be no rising of the water: the effect of the attraction upon the water would be the same as if there were no attraction at all.

If the attraction of the moon is sufficient to raise a high tide on the open ocean, why can she not raise a tide in the Mediterranean or Baltic, and other smaller inland lakes? "In small collections of water," it is said, "the moon acts with the same line of attraction, or nearly so, upon every portion of the surface at once, and, therefore, the whole of the waters being equally elevated at the same period, no part of them is ever higher than the other."

But the same takes place in the open sea: there "the moon acts with the same line of attraction upon a similar portion of surface," beyond which the waters by degrees, more and more, cease to be within her grasp; and yet it is said "that she raises up the parts immediately under her." This is equal to saying that a loadstone attracts a large piece of iron better than a small one. "The moon raising up the parts of water immediately under her,"